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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/802,563	03/17/2004	Hong Yu Yu	NUS03-001	3494

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STEPHEN B. ACKERMAN
28 DAVIS AVENUE
POUGHKEEPSIE, NY 12603

EXAMINER	
KIM, SU C	

ART UNIT	PAPER NUMBER
2823	

MAIL DATE	DELIVERY MODE
04/03/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/802,563	YU ET AL.	
	Examiner	Art Unit	
	SU C. KIM	2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *19 March 2008*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *8-12,14-24,26,27,35,37,39-43,45-47,54-56,58 and 59* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *8-12,14-24,26,27,35,37,39-43,45-47,54-56,58 and 59* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *17 March 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 3/5/2008 has been entered.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claims 8, 24, 35, &45 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 8, 24, 35, & 45, reciting “an atomic ratio of nitrogen and hafnium of said hafnium nitride layer is adjusted to adjust the work-function of said gate electrode wherein said atomic ration of nitrogen to hafnium remains greater than one", adjust work-function of said gate electrode by controlling content of nitrogen (N2) or content of hafnium (Hf) would not affect adjust work function because the hafnium nitride (HfN) consists of 1 atom of Hf and 1 atom of Nitrogen and stoichiometric structure will not affected by nitrogen content or hafnium content (more or less, still produce same HfN composition).

Please specify how to adjust work-function by controlling contents of Hf or N2 in HfN composition.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 8-9, 14, 24, 26-27, 35, 39, & 58 arerejected under 35 U.S.C. 103(a) as being unpatentable over Haukka et al. (US 2004/0104439) in view of Kraus et al. (US 20050042373).

Regarding claims 8, Haukka discloses a method for fabricating a CMOS semiconductor device structure comprising gate electrodes, said method comprising:

providing a dielectric layer 110 & 119 on a substrate 101;

depositing a hafnium nitride layer 112 on said dielectric layer 110 & 119 (Fig. 1b, paragraph 0031):

depositing a capping layer 114 (Fig. 1b) on said hafnium nitride layer 112 (Fig. 1b);

patterning said hafnium nitride layer (paragraph 0014) and said capping layer and said dielectric layer to form said CMOS gate electrodes (Fig. 1b).

Haukka fails to teach an atomic ratio of nitrogen (paragraph 0038) and hafnium of said hafnium nitride layer is adjusted to adjust the work-function of said gate electrodes where said atomic ratio of nitrogen to hafnium remains greater than one.

However, Kraus discloses an atomic ratio of nitrogen and hafnium of said hafnium nitride layer is adjusted to adjust the work-function of said gate electrodes where said atomic ratio of nitrogen to hafnium remains greater than one (paragraph 0026, lines 6-7, note: the metal atoms might be present in the conductive metal nitride of the layer at an atomic ratio of greater than or less than 1:1).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of applicant(s) claimed invention was made to provide Haukka with an atomic ratio of nitrogen and hafnium of said hafnium nitride layer is adjusted to adjust the work-function of said gate electrodes where said atomic ratio of nitrogen to hafnium remains greater than one as taught by Kraus in order to reduced-to-practive in the dposition of an HFN film (paragraph 0028).

Regarding claim 9, as applied to claim 8, Haukka and Kraus in combinations disclose that said depositing of said hafnium nitride layer comprises flowing Nitrogen and argon atoms (paragraph 0038, inactive gas) into a chamber simultaneously wherein said chamber contains said substrate and a hafnium target.

Regarding claim 14, as applied to claim 8, Haukka and Kraus in combinations disclose that impurity doping into said hafnium nitride layer 112 (Fig. 1b) to tune the work-function of said gate electrode (paragraph 0036).

Regarding claim 24, Haukka discloses a method for fabricating a CMOS semiconductor device structure comprising gate electrodes, said method comprising:

providing a dielectric layer 110 & 119 on a substrate 101;

depositing a first metal layer 112 on said dielectric 101 wherein said depositing of said first metal layer 112 (Fig. 1b) comprising flowing Nitrogen and argon atoms into a chamber simultaneously wherein said chamber contains said substrate and a hafnium target to form hafnium nitride first metal layer 112 (Fig. 1b); and

depositing a second metal capping layer 114, said first metal layer 112, and said dielectric layer 110 & 119 (Fig. 1b) to form said CMOS gate electrodes; and

forming source and drain region 102 within said substrate adjacent to said CMOS gate electrode (Fig. 1b).

However, Kraus discloses an atomic ratio of nitrogen and hafnium of said hafnium nitride layer is adjusted to adjust the work-function of said gate electrodes where said atomic ratio of nitrogen to hafnium remains greater than one (paragraph 0026, lines 6-7, note: the metal atoms might be present in the conductive metal nitride of the layer at an atomic ratio of greater than or less than 1:1).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of applicant(s) claimed invention was made to provide Haukka with an atomic ratio of nitrogen and hafnium of said hafnium nitride layer is adjusted to adjust the work-function of said gate electrodes where said atomic ratio of nitrogen to hafnium remains greater than one as taught by Kraus in order to reduced-to-practive in the dposition of an HFN film (paragraph 0028).

Regarding claim 26, as applied to claim 24, Haukka and Kraus in combinations disclose that said second metal capping layer 114 comprises tungsten or tantalum nitride (paragraph 0032).

Regarding claim 27, as applied to claim 24, Haukka and Kraus in combinations disclose that said first and second metal layer are deposited by PVD or CVD (paragraph 0056).

Regarding claim 35, Haukkad discloses a method for fabricating a CMOS semiconductor device structure comprising;

providing a dielectric layer 109 & 110 on a substrate 101 (Fig. 1b);

depositing a hafnium nitride layer 112 on said dielectric layer 110 & 119 wherein said depositing comprises flowing Nitrogen and Argon atom (paragraph 0038, inactive gas) into a chamber simultaneously wherein said chamber contains said substrate and a hafnium target;

depositing a titanium nitride or tungsten capping layer on said hafnium nitride layer(paragraph 0032);

patterning said hafnium nitride layer 112 and said capping layer 114 and said dielectric layer 109 & 110 (Fig. 1b) to form CMOS gate electrodes; and

forming source and drain 102 (Fig. 1) within said substrate adjacent to said CMOS gate electrode.

However, Kraus discloses an atomic ratio of nitrogen and hafnium of said hafnium nitride layer is adjusted to adjust the work-function of said gate electrodes where said atomic ratio of nitrogen to hafnium remains greater than one (paragraph 0026, lines 6-7, note: the metal atoms might be present in the conductive metal nitride of the layer at an atomic ratio of greater than or less than 1:1).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of applicant(s) claimed invention was made to provide Haukka with an atomic ratio of nitrogen and hafnium of said hafnium nitride layer is adjusted to adjust the work-function of said gate electrodes where said atomic ratio of nitrogen to hafnium remains greater than one as taught by Kraus in order to reduced-to-practive in the dposition of an HFN film (paragraph 0028).

Regarding claim 37, as applied to claim 35, Haukka and Kraus in combinations disclose that said dielectric layer comprises HfO2 (paragraph 0015), silicon dioxide, silicon nitride, nitride silicon dioxide, zirconium oxide, aluminum oxide, tantalum pentoxide, barium strontium titanates, or crystalline oxide (paragraph 0033).

Regarding claim 39, as applied to claim 35, Haukka and Kraus in combinations disclose that impurity doping into said hafnium nitride layer (Fig. 1b) to tune the work-function of said gate electrode (paragraph 0036).

Regarding claim 58, as applied to claim 24, Haukka and Kraus in combinations disclose that impurity doping into said hafnium nitride layer 112 (Fig. 1b) to tune the work-function of said gate electrode (paragraph 0036).

6. Claims 10, 12, 15, 54, 56, & 59 are rejected under 35 U.S.C. 103(a) as being unpatentable over Haukka et al. (US 2004/0104439) in view of Kraus et al. (US 20050042373) and further in view of Optimum range.

Regarding claim 10, as applied to claim 9, Haukka and Kraus in combinations disclose that argon and nitrogen flow rates are kept (paragraph 0038).

Haukka and Kraus in combinations fail to teach flow rates are kept as constant at 25 sccm and 5 sccm.

However, notwithstanding, one of ordinary skill in the art would have been led to the recited dimensions through routine experimentation and optimization. Applicant has not disclosed that the dimensions are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical, and it appears prima facie that the process would possess utility using another dimension. Indeed, it has been held that mere dimensional limitations are prima facie obvious absent a disclosure that the limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical.

Regarding claims 12 & 56, as applied to claims 8 & 24 , Haukka and Kraus in combinations disclose said dielectric layer comprising HfO2 and wherein said dielectric layer is subjected to post-deposition annealing (PDA) in N2 ambient (paragraph 0055).

Haukka and Kraus in combinations fail to teach the post-deposition annealing at 700^{o}C.

However, notwithstanding, one of ordinary skill in the art would have been led to the recited dimensions through routine experimentation and optimization. Applicant has not disclosed that the dimensions are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical, and it appears prima facie that the process would possess utility using another dimension. Indeed, it has been held that mere dimensional limitations are prima facie obvious absent a disclosure that the

limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical.

Regarding claims 15 & 59, as applied to claims 8 & 24, Haukka and Kraus in combinations disclose that thermal treatment of said hafnium nitride by RTA (paragraph 0055).

Haukka and Kraus in combinations fail to teach thermal treatment of said hafnium nitride at about 1000^{o}C for about 20 second.

However, notwithstanding, one of ordinary skill in the art would have been led to the recited dimensions through routine experimentation and optimization. Applicant has not disclosed that the dimensions are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical, and it appears prima facie that the process would possess utility using another dimension. Indeed, it has been held that mere dimensional limitations are prima facie obvious absent a disclosure that the limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical.

Regarding claim 54, as applied to claim 24, Haukka and Kraus in combinations disclose that argon and nitrogen flow rates are kept (paragraph 0038).

Haukka and Kraus in combinations fail to teach flow rates are kept as constant at 25 sccm and 5 sccm.

However, notwithstanding, one of ordinary skill in the art would have been led to the recited dimensions through routine experimentation and optimization. Applicant has not disclosed that the dimensions are for a particular unobvious purpose, produce

an unexpected result, or are otherwise critical, and it appears prima facie that the process would possess utility using another dimension. Indeed, it has been held that mere dimensional limitations are prima facie obvious absent a disclosure that the limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical.

7. Claims 11& 55 are rejected under 35 U.S.C. 103(a) as being unpatentable over Haukka et al. (US 2004/0104439) in view of Kraus et al. (US 20050042373) and further in view of Kubota et al. (US 2004/0087124).

Regarding claims 11 & 55, as applied to claims 8 & 24, Haukka & Kraus in combinations disclose that said dielectric layer comprises HfO2 (Haukka, paragraph 0043).

Haukka & Kraus in combinations fails to teach HfO2 is deposited at 400 ^{o}C by using MOCVD.

However, Kuboda discloses HfO2 is deposited by using MOCVD (paragraph 0019).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of applicant(s) claimed invention was made to provide Haukka & Kraus in combinations in combination with HfO2 using a MOCVD cluster tool as taught by Kubota in order to produce thin dielectric layer.

Haukka, Kraus and Kuboda in combinations fail to teach HfO2 is deposited at 400 ^{o}C

However, notwithstanding, one of ordinary skill in the art would have been led to the recited dimensions through routine experimentation and optimization. Applicant has not disclosed that the dimensions are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical, and it appears prima facie that the process would possess utility using another dimension. Indeed, it has been held that mere dimensional limitations are prima facie obvious absent a disclosure that the limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical.

8. Claims 40- 43, 45-46 are rejected under 35 U.S.C. 103(a) as being unpatentable over Eppich et al(US 7,019,351) in view of Haukka et al. (US 2004/0104439)

Regarding claim 40, Eppich discloses a method for fabricating a CMOS semiconductor device structure comprising:

provide a dielectric layer 20 on a substrate 16 (Fig. 5)

depositing a first metal layer 24 (Fig. 5)

depositing a second metal capping layer 30 on said first metal layer 24 (Fig.5), said second metal capping layer comprising a hafnium nitride (col. 7, lines 27-29)

patterning said first metal 24 , said second metal capping layer, 30 to form CMOS gate electrodes (Fig. 5); and

forming source and drain regions 52 within said substrate adjacent to said CMOS gate electrodes (Fig. 6).

Eppich fails to teach depositing the second metal capping comprising flowing Nitrogen and Argon atoms into a chamber simultaneously wherein said chamber contains said substrate and a hafnium target to form hafnium nitride layer.

However, Haukka discloses the metal layer comprising flowing Nitrogen and Argon atoms into a chamber simultaneously wherein said chamber contains said substrate and a hafnium target to form (paragraph 0038, inactive gas) hafnium nitride layer 112 (Fig. 1b).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of applicant(s) claimed invention was made to provide Eppich with depositing the second metal capping comprising flowing Nitrogen and Argon atoms into a chamber simultaneously wherein said chamber contains said substrate and a hafnium target to form hafnium nitride layer as taught by Haukka in order to enhance device performance.

Regarding claim 41, as applied to claim 40, Eppich and Haukka in combination disclose that said dielectric layer comprises HfO2 (Haukka, paragraph 0043).

Regarding claim 42, as applied to claim 40, Eppich and Haukka in combination disclose that said first and second metal layer are deposited by PVD or CVD (Haukka, paragraph 0056).

Regarding claim 43, as applied to claim 40, Eppich and Haukka in combination disclose that said first metal layer comprises tungsten or tantalum nitride (Eppich, Col. 6, lines 52-59).

Regarding claim 45, as applied to claim 40, Eppich and Haukka in combination disclose that adjusting the flow rate of said Nitrogen and argon atoms (Haukka,

paragraph 0038, inactive gas) to adjust the work-function of said gate electrodes wherein the atomic ration of nitrogen to hafnium remains greater than or equal to one (Haukka, paragraph 0047, HfN is atomic ratio of 1 to 1):

Regarding claim 46, as applied to claim 40, Eppich and Haukka in combination disclose that impurity doping into said hafnium nitride layer (Haukka, Fig. 1b) to tune the work-function of said gate electrode (Haukka, paragraph 0036).

Claim 47 is rejected under 35 U.S.C. 103(a) as being unpatentable over Eppich et al(US 7,019,351) in view of Haukka et al. (US 2004/0104439) and further in view of Optimum range.

Regarding claim 47, as applied to claim 40, Li and Haukka in combination disclose that thermal treatment of said hafnium nitride by RTA (Haukka, paragraph 0055).

Eppich and Haukka in combinations fail to teach thermal treatment of said hafnium nitride at about 1000^{o}C for about 20 second.

However, notwithstanding, one of ordinary skill in the art would have been led to the recited dimensions through routine experimentation and optimization. Applicant has not disclosed that the dimensions are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical, and it appears prima facie that the process would possess utility using another dimension. Indeed, it has been held that mere dimensional limitations are prima facie obvious absent a disclosure that the limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SU C. KIM whose telephone number is (571)272-5972. The examiner can normally be reached on Monday - Thursday, 9:00AM to 7:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew S. Smith can be reached on (571) 272-1907. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Su C Kim/
Examiner, Art Unit 2823

/W. David Coleman/
Primary Examiner, Art Unit 2823